

The effects of a calisthenics training intervention on posture, strength and body composition

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ABSTRACT

BACKGROUND Calisthenics was a term used to define a generic set of body weight exercises. Such term is now used to define a world wide spread discipline based on body weight and gymnastics exercises.

OBJECTIVE The aim of this study was to administer a calisthenics training protocol and evaluate its effects on posture, strength and body composition of untrained individuals.

METHODS 28 male participants (24.2 ± 4.2 years; 67.0 ± 8.3 Kg; 173.3 ± 5.2 cm) were divided into two groups, a Calisthenics based intervention group (SG) and a control group (CG). The SG exercised for 8 weeks. Each participant underwent a body composition analysis, a postural assessment, a handgrip test, a push-up and a pull-up test. Each participant was tested at baseline and post intervention.

RESULTS The SG improved their posture (with open eyes $p<0.001$ and with closed eyes $p<0.05$), their strength (push-up test $p<0.01$ with a 16.4% increase and pull up test $p<0.0001$ with a 39.2% increase) and their body composition (Fat mass 14.8 ± 5.1 vs. 11.4 ± 5.9 , $p<0.01$). No difference was shown for the handgrip test. No significant differences were displayed in any variable of the CG between pre and post measures.

CONCLUSIONS Calisthenics training is a feasible and effective training solution to improve posture, strength and body composition without the use any major training equipment.

Keywords Sport, Exercise, Calisthenics, Strength, Posture.

Introduction

The term calisthenics originally referred to a set of body weight exercises used in the United States to improve the general fitness level of female school children[1]. The term of Greek origins comes from the words “Kàlos” that means beauty and “Sthénos” that means strength. In other parts of the world, for example in Australia, such term indicates a female-only competitive sport that incorporates skills from dance and gymnastics[2]. Over the years, this term has been generalized to a set of bodyweight skills aiming to improve health and fitness. These exercises have been used in different environments such as medical[3], military[4] and schools[5, 6] to improve individuals physical features. The term calisthenics is now used to indicate a defined physical activity with similar features to gymnastics but mainly performed outdoors, in parks, using high bars, parallel bars and rings. The aim of this discipline is to increase strength in a variety of its expressions, such as performing the maximum number of repetitions of pull-ups or parallel bar dips with and without an external overload, for strength endurance, or to lift the maximum possible weight in the previous mentioned exercises, for maximal strength, and perform gymnastic based skills of increasing difficulty, for isometric strength. This discipline is also known as street workout and although there still isn't a federation recognized by the International Olympic Committee (CIO), there is a private organization known as World Street Workout and Calisthenics Federation (WSWCF)[7], with its headquarters in Riga, Latvia, that promotes its diffusion and organizes local and international competitions. There are also other private organizations that organize and promote the diffusion of calisthenics worldwide and organize international competitions[8].

Calisthenics due to its low costs of practice, being this mainly practiced in public parks and its easiness, requiring none or minimal equipment (such as a high bar or parallel bars) has been seen to be effective for aesthetic physical development and has been gaining increasing popularity over the years[9]. However, to date no scientific publication has studied or taken into account such discipline, and besides the results provided by “classic calisthenics” studies on children and military, where the use of burpees, dumbbells, elastic bands and aerobic training[4, 10] provides positive results, the effects of such sport on physical characteristics still needs to be investigated.

Therefore, the aim of this study was to administer a calisthenics training protocol to untrained individuals and evaluate the changes in physical characteristics, as strength endurance, posture and body composition expressed as fat mass and free fat mass after an 8 week intervention.

Materials and Methods

Participants

28 male participants (24.2 ± 4.2 years; 67.0 ± 8.3 Kg; 173.3 ± 5.2 cm) were divided into two groups, a Calisthenics based intervention group (SG) and a control group (CG). The SG comprised 12 male participants (24.8 ± 6.2 years; 62.6 ± 8.9 Kg; 171.8 ± 3.9 cm), whereas the CG comprised 16 male participants (23.7 ± 1.8 years; 70.2 ± 6.2 Kg; 174.4 ± 5.8 cm). The participants were randomly assigned to each group. A longitudinal experimental study was adopted to investigate the effects of a Calisthenics based training in untrained men on posturographic parameters, strength and body composition with the main focus on body fat variations. A two group, repeated measures (pre- and post-testing) design was used. The calisthenics group carried out 8 weeks of calisthenics based training 3 times a week. Posturographic parameters, strength and body composition were the dependent variables. Calisthenics training was the independent variable. All the parameters were measured at baseline and after the 8 week training intervention. There were no significant differences between groups at baseline for all the anthropometric measures.

Before data collection, written informed consent was obtained from all subjects, and the investigation was approved by the university's Institutional Review Board for the Protection of Human Subjects.

Individuals with traumas, taking any kind of medication or with chronic pathologies were excluded from investigation. Individuals, who were also engaged in structured training activities, strength based sports or athletes, were also excluded from investigation. The study was performed in compliance with the Helsinki Declaration.

Procedures

The participants were divided into 2 groups: a Calisthenics based Intervention and a Control Group. Each participant underwent: 1) a body composition analysis, 2) a posturographic assessment, 3) a hand-grip test, 4) a push-up test and a pull-up test both to repetition maximum(RM). The tests were administered in the above listed order, to allow a proper posturographic assessment uninfluenced by the strength tests.

Grip-strength was used to evaluate upper limb general strength[11]. The pull-up and push up tests were used to evaluate endurance-strength as indicators of the increase in the physical level of the participants[12-15]. Secondly, calisthenics is born as a weight-free discipline, thus the strength evaluation was carried out without the use of overloads. Each test was performed at baseline and after 8 weeks. All strength assessments were undertaken at the same day at the same time and by the same investigator.

The SG group trained three times a week, using the protocol defined in Table 1, on non-consecutive days whereas the CG continued with their normal daily routines without engaging in any structured training activities. All the participants of the SG group were familiarized with the exercises before the training session and all of them were able to complete the training regimen.

Body-composition analysis

An Akern bioelectrical impedance analysis (BIA) 101 physiological data analyzer (AKERN SRL, RJL Systems, Detroit, USA) was used to perform a BIA in the morning after an overnight fast and the first urine void. All procedures were performed with the subjects lying supine on a non-conductive flat surface after their shoes, socks, and any kind of metal jewelry (earrings, bracelets, necklaces, etc) had been removed. The transmitting electrodes were placed on the posterior surface of the right hand at the distal end of the third metacarpal bone and on the anterior surface of the right foot at the distal

end of the second metatarsal bone, at least 5 cm from the receiving electrodes, which were positioned between the radial and ulnar styloids and between the medial and lateral malleoli of the ankle.

Postural assessment

For the posturographic assessment, each participant performed the Romberg test using standardized positioning: The feet were placed side-by-side, forming an angle of 30° and both heels were 4 cm apart. Posturography was measured using the FreeMed posturography system, including the FreeMed stabilometric platform and the FreeStep v.1.0.3 software. The system samples real time postural sway at 100 Hz[16]. The sensors, coated with 24K gold, guarantee repeatability and reliability of the instrument (produced by Sensor Medica, Guidonia Montecelio, Roma, Italy). Participants were asked to perform the standardized sway test on the stabilometric platform. Data from the platform were converted in accordance with instructions provided by the manufacturer and transformed into coordinates of the center of pressure (CoP). Participants repeated the static standing measures with eyes open (OE) during the first analysis and with eyes closed (CE) during the second analysis. The following parameters of the statokinesigram were considered for both CO and CE: length of sway of the CoP (SP); ellipse surface area (ES); these derive from the coordinates of the CoP along the frontal (X; right-left; x-mean) and sagittal (Y; forward-backward; y-mean) planes[17].

Strength measures

Grip strength test: Hand-grip strength was measured through a digital dynamometer (KERN MAP 80K1, KERN&Sohn GmbH, Barlinger, Germany). Each participant performed three trials with both hands with a two minute rest between each trial. The participants were instructed to hold the dynamometer in the hand in a comfortable

position with the arm fully extended and were instructed not to touch any part of the body with the dynamometer, except for the hand being measured. The display of the dynamometer was aligned to the face of the examiner. The participants were standing during the entire test with the arm straight down at the side, the elbow in full extension, the forearm in neutral position, and the wrist also extended. The highest of the three trials was considered for statistical analysis.

Push-up test: The Pull up test was performed on a flat, stable surface, with the hands placed slightly wider than shoulder-width apart, and fingers pointed forward with the body horizontal to the surface. The participants were instructed to maintain a neutral spine and feet together position, throughout the entire movement. Once again, in order for the repetition to be recorded, the correct depth needed to be met. This was considered when each elbow formed an angle of at least 90° during the eccentric phase of the movement. Participants were however instructed to lower the body until the chest was within 2 inches from the floor during the eccentric phase of the movement and had to fully extend the arms on the concentric phase of the movement[18]. The test ended when the participants were no longer able to perform additional repetitions or when they could no longer maintain a correct posture. Each participant performed a single trial.

Pull-up test: The pull up test was performed with each participant grasping an overhead bar with a pronated grip and the elbows completely extended with the hands placed slightly wider than shoulder-width apart. A repetition was counted each time the participant raised his body until the chin was above the bar during the concentric phase of the movement and then returned to the starting position during the eccentric phase of the movement. The test ended when the participants were no longer able to perform

additional repetitions or when they could no longer maintain a correct posture. Each participant performed a single trial.

Training Protocol: The participants of the SG group exercised three days a week on non consecutive days.

The training protocol concentrated on upper limb extensors on the first training day, on the upper limb flexors on the second training day and on the lower limbs and additional technical exercises the third training day.

Every training day the participants warmed up for 5 minutes using specific low intensity exercises targeting the muscles used during the subsequent training session. Elastic rubber bands and weight-free exercises were used during the warm up phase.

The training routine is described in table 1. During the first four weeks all the dynamic exercises comprised 4 sets performing repetitions to exhaustion, whereas 6 sets performing isometric holds for 10 seconds for each set were administered for the static exercises. The only differences were during the third day, where the wall handstand hold, considered as an isometric exercise, was held for 30 seconds for each set. The leg training adopted was a Tabata interval-training program that consisted in completing 20-second all-out squats and lunges with a 10-second rest period in-between for 8 rounds[19]. The fifth and sixth week a set was added to each exercise, and another set was also added the seventh and eighth week, with exception of the tabata interval-training program. Core training was performed using the hollow body position (Fig. 1f) administered for 4 sets holding the isometric position for 45''. At the end of each training session, stretches of the targeted muscles were performed. Each stretch was maintained for 1 consecutive minute for 3 sets for each muscle. Each exercise is illustrated in Figure 1.

Statistical Analysis

Descriptive statistics as means and standard deviations have been used to present data. Percentages have also been used to present differences between pre and post intervention. A paired t-test was used to analyze differences between pre and post intervention within groups. An unpaired t-test was used to analyze differences between groups when appropriate. Significance was set at $p < 0.05$ for all analysis. Statistica 10.0 (Statsoft, Tulsa, OK, USA) was used for analysis and Prism 6 (GraphPad software, Inc, CA, USA) for graph creation.

Results

Baseline measures are summarized in table 2. The posturographic assessment showed a significant decrease of the length of the statokinesigram between pre and post measures (847.4±163.3mm vs. 675.8±211.9mm, $p<0.001$, and 911.2±157.1mm vs. 668.9±150.05mm, $p<0.05$, OE and CE, respectively) but no difference in the surface of the ellipse (64.90±56.99mm² vs. 69.63±89.88mm² and 29.42±15.07mm² vs. 50.22±35.15mm², OE and CE, respectively) resulting in an improvement of the stability of the participants for the SG group in both the CE and OE tasks. No differences were shown in the CG for both the length of the statokinesigram and the surface of the ellipse between pre and post measures (694.8±321.3mm vs. 610.5±153.5mm and 721.0±322.0mm vs. 645.5±175.9mm for the length of the statokinesigram and 44.63±38.60mm² vs. 55.84±91.72mm² and 53.44±64.81mm² vs. 44.40±42.38mm² for the surface of the ellipse, OE and CE, respectively) (Fig.2).

No differences were shown in the Hand-grip strength test for both the SG and CG in both hands. A significant improvement in both the push-up and pull-up tests was shown in the SG group (45.3±8.75 vs. 52.75±12.8, $p<0.01$, and 10.8±3.1 vs. 15.1±1.8, $p<0.0001$, in the push-up and pull-up tests, respectively) with an increase of 16.4% and 39.2%, respectively, whereas no differences were shown in the CG neither in the hand grip, push-up and pull-up test (Fig.3 and 4, respectively).

A decrease in fat mass was shown after the intervention period for the SG group (14.8±5.1 vs. 11.4±5.9, $p<0.01$) whereas no differences were shown in the CG (17.1±3.6 vs. 16.7±2.9, Fig.5). Results are summarized in table 3.

Discussion

The aim of this study was to evaluate physical characteristics as strength, posture and body composition in untrained individuals after a calisthenics training intervention and our main results show a general improvement of physical features after the 8 week intervention.

The main improvement was found on the length of the statokinesigram, with a decrease from the baseline measures in both OE and CE tasks in the SG. The statokinesigram is a bidimensional representation of the foot base ground-reaction vector, known as CoP and is the result of the body sway of the frontal and sagittal planes on the horizontal plane[20]. Such decrease indicates a reduced body sway and therefore an increased postural control meaning the participants were more stable [21]. Such improvement can be explained by the core training that the SG underwent. The hollow body position as a specific core exercise and the planche and front lever in a secondary manner (in both dynamic and static phases) target the core muscles that provide a stabilizing effect. Similar results were achieved by Bjerkefors et al.[22] after transversus abdominis training with and without body hollowing. The authors report an increase of the activation of the deep abdominal wall that has been described as a specific supporting and stabilizing muscle of the spine. An increase of the activation of the transversus abdominis also increases feedforward postural adjustments, thus leading to an improved motor control[23]. Other responsible mechanism could be the vestibular adaptation due to the inverted position maintained during the handstand-holds[24, 25]. The inverted stance position may be compared to vestibular rehabilitation training that is mainly based on head and eye movements[25]. An exercise that aims to improve proprioception and balance on hands may also be responsible for the postural improvements in an upright position. This could also explain

the improvements achieved with CE, by the SG group, where the posture and the sway aren't influenced by visual stimuli.

Other main improvements seen in the SG were the measures from the push-up and the pull-up tests with an increase of 16.4% and 39.2%, respectively, compared to the baseline measures. It is interesting to note that the participants did not specifically train these movements. However, the Planche exercises as seen in figure 1 (from 1a to 1b and back to 1a for the dynamic Planche and figure 1b for the static planche) have as target muscles the upper limbs (mainly the extensor musculature) with involvement of the deltoids during the lean phase, the triceps and the forearms during the whole movement and the pectoralis minor, the serratus anterior, the teres major, the teres minor and the trapezius during the protraction (in the lean phase of the movement) and the retraction during the returning phase. These muscles have been seen through electromiographic assessments to be involved during the push up exercise[26, 27]. Other muscles are also involved during the stabilizing part of the movement such as the erector spinae and the rectus abdominis.

The front lever exercises as seen in figure 1 (from 1c to 1d for the front lever pulls and figure 1b for the static front lever) have as target muscles the deltoids during the stabilizing phase of the movement, the latissimus dorsi, the biceps brachii and the brachioradialis during the concentric phase of the movement during the front lever pulls, the triceps during the static front lever and the pectoralis minor and the serratus anterior during the protraction of the scapulas. Other muscles are also involved during the stabilizing part of the movement such as the rectus abdominis and the erector spinae. These same muscles have been seen through electromiographic assessments to be activated during the pull-up exercise[28-30]. There is no doubt that notwithstanding the

pushups and the pull ups were not specifically trained an increase in the endurance-strength of same muscles that are involved during those exercises will also be beneficial to improve general upper body strength. It has to be noted that the choice of the endurance tests was determined by the model provided by the calisthenics training. However, it has been previously reported that these tests, notwithstanding are a popular mean for the assessment of physical abilities, are related to problems in discriminating individuals at the low end of the scale. Many individuals across different studies have been seen to perform a 0 in such tests, with the weight of each participant being a limiting factor in the execution of the tests[31-33]. Although none of the tested participants scored a 0 at any test.

Notwithstanding the increase in pushups and pull ups, the results of the hand grip test did not show any improvement in either group. Probably, due to the nature of the test, 8 weeks are not enough to promote increases in such measure. However, the two groups showed similar measures, either at baseline and post-intervention, confirming that the outcomes of the hand-grip dynamometry are mainly age related[11, 34].

Other improvement shown by the SG was the reduction in fat mass from $14.8 \pm 5.1\%$ to $11.4 \pm 5.9\%$ (-3.4%) after the 8 week intervention. Such reduction is in line with the results of other studies implementing high intensity physical protocols for the improvement of physical features[35-37]. Calisthenics can be seen as a form of resistance training and for such induces all the specific adaptations of this typology of training[38, 39].

Conclusions

Calisthenics is an effective physical activity for the improvement of postural sway, strength-endurance and has a positive effect on body composition, significantly reducing body fat mass. Such activity has been seen to elicit physical features in untrained individuals allowing all the participants to complete the training program. It can therefore be considered easy to practice and accessible to almost everyone. Adequate training facilities should be implemented to allow the diffusion of calisthenics as a form of physical fitness and well being.

Conflicts of Interest

The authors declare no conflicts of interest.

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References

- [1] Beecher C. Physiology and calisthenics for schools and families: New York : Harper & Bros., 1856; 1856.
- [2] Otzen R. Recovering the past for the present: the history of Victorian calisthenics. *Lilith*. 1988;5:96-112.
- [3] Mark MV. A review of the use of the specific muscle calisthenics unit. *Am J Optom Arch Am Acad Optom*. 1957 Dec;34(12):670-674.
- [4] Gist NH, Freese EC, Ryan TE, Cureton KJ. Effects of Low-Volume, High-Intensity Whole-Body Calisthenics on Army ROTC Cadets. *Mil Med*. 2015 May;180(5):492-498.
- [5] Cui Y, Liu X, Liu X, Wu J, Zhao M, Ren J, et al. Evaluation of the exercise workload of broadcast calisthenics for children and adolescents aged 11-17 years. *J Sports Sci*. 2011 Feb;29(4):363-371.
- [6] Hou ZW, Li YL, Zhang LH, Yu H, Miao YH, Gu XH. Effect of Chinese traditional healthcare exercises on 136 junior school students. *Chin J Integr Med*. 2014 Mar;20(3):232-234.
- [7] Federation WSWaC. World Street Workout and Calisthenics Federation 2011. Available from: <http://www.wswcf.org/>.
- [8] Organization WC. World Calisthenics Organization 2012. Available from: <http://www.worldcalisthenics.org/>.
- [9] Krishnan K, Arumugam C. The Effect Of Callisthenic And Dumbbell Exercise On Muscular Strength Endurance And Flexibility Of Rural School Boys 2013.
- [10] Farinatti PT, Rubini EC, Silva EB, Vanfraechem JH. Flexibility of the elderly after one-year practice of yoga and calisthenics. *Int J Yoga Therap*. 2014 Sep;24:71-77.
- [11] Bohannon RW. Muscle strength: clinical and prognostic value of hand-grip dynamometry. *Curr Opin Clin Nutr Metab Care*. 2015 Sep;18(5):465-470.
- [12] Wang R, Hoffman JR, Sadres E, Bartolomei S, Muddle TW, Fukuda DH, et al. Evaluating Upper-Body Strength and Power from a Single Test: The Ballistic Push-Up. *J Strength Cond Res*. 2017 Feb 01.
- [13] Sakamaki T. [A study of the burpee push up test as a simple method of measuring endurance]. *Nihon Ika Daigaku Zasshi*. 1983 Apr;50(2):173-190.
- [14] Engelman ME, Morrow JR, Jr. Reliability and skinfold correlates for traditional and modified pull-ups in children grades 3-5. *Res Q Exerc Sport*. 1991 Mar;62(1):88-91.
- [15] Thomas E, Bianco A, Bellafiore M, Battaglia G, Paoli A, Palma A. Determination of a strength index for upper body local endurance strength in sedentary individuals: a cross sectional analysis. *SpringerPlus*. 2015;4:734.
- [16] Duarte M, Freitas SM. Revision of posturography based on force plate for balance evaluation. *Rev Bras Fisioter*. 2010 May-Jun;14(3):183-192.
- [17] Scoppa F, Capra R, Gallamini M, Shiffer R. Clinical stabilometry standardization: basic definitions--acquisition interval--sampling frequency. *Gait Posture*. 2013 Feb;37(2):290-292.
- [18] Bianco A, Lupo C, Alesi M, Spina S, Raccuglia M, Thomas E, et al. The sit up test to exhaustion as a test for muscular endurance evaluation. *Springerplus*. 2015;4:309.

- [19] Rebold MJ, Kobak MS, Otterstetter R. The influence of a Tabata interval training program using an aquatic underwater treadmill on various performance variables. *J Strength Cond Res.* 2013 Dec;27(12):3419-3425.
- [20] de Oliveira JM. Statokinesigram normalization method. *Behav Res Methods.* 2016 Feb 19.
- [21] Prieto TE, Myklebust JB, Hoffmann RG, Lovett EG, Myklebust BM. Measures of postural steadiness: differences between healthy young and elderly adults. *IEEE Trans Biomed Eng.* 1996 Sep;43(9):956-966.
- [22] Bjerkefors A, Ekblom MM, Josefsson K, Thorstensson A. Deep and superficial abdominal muscle activation during trunk stabilization exercises with and without instruction to hollow. *Man Ther.* 2010 Oct;15(5):502-507.
- [23] Tsao H, Hodges PW. Persistence of improvements in postural strategies following motor control training in people with recurrent low back pain. *J Electromyogr Kinesiol.* 2008 Aug;18(4):559-567.
- [24] Fiori F, David N, Aglioti SM. Processing of proprioceptive and vestibular body signals and self-transcendence in Ashtanga yoga practitioners. *Front Hum Neurosci.* 2014;8:734.
- [25] Alsalaheen BA, Whitney SL, Marchetti GF, Furman JM, Kontos AP, Collins MW, et al. Performance of high school adolescents on functional gait and balance measures. *Pediatr Phys Ther.* 2014 Summer;26(2):191-199.
- [26] Marcolin G, Petrone N, Moro T, Battaglia G, Bianco A, Paoli A. Selective Activation of Shoulder, Trunk, and Arm Muscles: A Comparative Analysis of Different Push-Up Variants. *J Athl Train.* 2015 Nov;50(11):1126-1132.
- [27] Torres RJ, Piraua AL, Nascimento VY, Santos PS, Beltrao NB, Oliveira VM, et al. Shoulder Muscle Activation Levels During the Push-Up Plus Exercise on Stable and Unstable Surfaces. *J Sport Rehabil.* 2016 Jun 14.
- [28] Youdas JW, Amundson CL, Cicero KS, Hahn JJ, Harezlak DT, Hollman JH. Surface electromyographic activation patterns and elbow joint motion during a pull-up, chin-up, or perfect-pullup rotational exercise. *J Strength Cond Res.* 2010 Dec;24(12):3404-3414.
- [29] Boccia G, Pizzigalli L, Formicola D, Ivaldi M, Rainoldi A. Higher Neuromuscular Manifestations of Fatigue in Dynamic than Isometric Pull-Up Tasks in Rock Climbers. *J Hum Kinet.* 2015 Sep 29;47:31-39.
- [30] Youdas JW, Keith JM, Nonn DE, Squires AC, Hollman JH. Activation of Spinal Stabilizers and Shoulder Complex Muscles During an Inverted Row Using a Portable Pull-up Device and Body Weight Resistance. *J Strength Cond Res.* 2016 Jul;30(7):1933-1941.
- [31] Rutherford WJ, Corbin CB. Validation of criterion-referenced standards for tests of arm and shoulder girdle strength and endurance. *Res Q Exerc Sport.* 1994 Jun;65(2):110-119.
- [32] Pate RR, Burgess ML, Woods JA, Ross JG, Baumgartner T. Validity of field tests of upper body muscular strength. *Res Q Exerc Sport.* 1993 Mar;64(1):17-24.
- [33] Nelson JK, Yoon SH, Nelson KR. A field test for upper body strength and endurance. *Res Q Exerc Sport.* 1991 Dec;62(4):436-441.

- [34] Bianco A, Jemni M, Thomas E, Patti A, Paoli A, Ramos Roque J, et al. A systematic review to determine reliability and usefulness of the field-based test batteries for the assessment of physical fitness in adolescents - The ASSO Project. *Int J Occup Med Environ Health*. 2015;28(3):445-478.
- [35] Paoli A, Pacelli QF, Moro T, Marcolin G, Neri M, Battaglia G, et al. Effects of high-intensity circuit training, low-intensity circuit training and endurance training on blood pressure and lipoproteins in middle-aged overweight men. *Lipids Health Dis*. 2013 Sep 03;12:131.
- [36] Martins C, Kazakova I, Ludviksen M, Mehus I, Wisloff U, Kulseng B, et al. High-Intensity Interval Training and Isocaloric Moderate-Intensity Continuous Training Result in Similar Improvements in Body Composition and Fitness in Obese Individuals. *Int J Sport Nutr Exerc Metab*. 2016 Jun;26(3):197-204.
- [37] Marcinko K, Sikkema SR, Samaan MC, Kemp BE, Fullerton MD, Steinberg GR. High intensity interval training improves liver and adipose tissue insulin sensitivity. *Mol Metab*. 2015 Dec;4(12):903-915.
- [38] Socha M, Fraczak P, Jonak W, Sobiech KA. Effect of resistance training with elements of stretching on body composition and quality of life in postmenopausal women. *Prz Menopauzalny*. 2016 Mar;15(1):26-31.
- [39] Ribeiro AS, Schoenfeld BJ, Silva DR, Pina FL, Guariglia DA, Porto M, et al. Effect of Two- Versus Three-Way Split Resistance Training Routines on Body Composition and Muscular Strength in Bodybuilders: A Pilot Study. *Int J Sport Nutr Exerc Metab*. 2015 Dec;25(6):559-565.

Tables

Table I. *Calisthenics based training protocol*

	Day 1		Day 2		Day 3	
	Exercise	SetsReps	Exercise	SetsReps	Exercise	SetsReps
Warm up	Warm up 5 minutes		Warm up 5 minutes		Warm up 5 minutes	
Training	Dynamic Planche lean	4 RM	Tucked front pull	4 RM	Squats	8 20''
	Static Planche lean	6 10''	Tucked front lever	6 10''	Lounges	8 20''
	Dips	4 RM	Australian Pulls	4 RM	Skin the cat	4 RM
Core	Hollow Body position	4 45''	Hollow Body Position	4 45''	Wall Handstand holds	4 30''
					Hollow body position	4 45''
Stretching	Stretching		Stretching		Stretching	

RM: Repetition maximum

Table II. *Anthropometric parameters and baseline measurements*

	CIG	CG
Age (years)	24.8±6.2	23.7±1.8
Weight (kg)	62.6±8.9	70.2±6.2
Height (CM)	171.8±3.9 cm	174.4±5.8
FM (%)	14.8±5.1	17.1±3.6
OE statokinesigram (mm)	847.4±163.3	694.8±321.3
CE statokinesigram (mm)	911.2±157.1	721.0±322.0
HG DX (kg)	43.8±7.2	44.4±9.7
HG SX (kg)	41.6±6.0	39.0±7.3
Push-up (reps)	45.3±8.75	31.75±9.6
Pull-up (reps)	10.8±3.1	5.62±3.5

Data are presented as means±standard deviation; FM: fat mass; OE: open eyes; CE: closed eyes; HG: hand grip; DX: right; SX: left.

Table III. Post intervention measurements

	CIG Pre	CIG Post	P	CG Pre	CG Post	P
FM (%)	14.8±5.1	11.4±5.9	<0.01	17.1±3.6	16.7±2.9	ns
OE statokinesigram (mm)	847.4±163.3	675.8±211.9	<0.001	694.8±321.3	610.5±153.5	ns
CE statokinesigram (mm)	911.2±157.1	668.9±150.05	<0.05	721.0±322.0	645.5±175.9	ns
HG DX (kg)	43.8±7.2	43.4±6.9	ns	44.4±9.7	45.35±9.6	ns
HG SX (kg)	41.6±6.0	40.1±7.05	ns	39.0±7.3	41.35±6.5	ns
Push-up (reps)	45.3±8.75	52.75±12.8	<0.01	31.75±9.6	34.12±7.3	ns
Pull-up (reps)	10.8±3.1	15.1±1.8	<0.0001	5.62±3.5	6.1±3.5	ns

Data are presented as means±standard deviation; FM: fat mass; OE: open eyes; CE: closed eyes; HG: hand grip; DX: right; SX: left. Significance is set at p<0.05; ns= non significative;